

Claims

- [c1] 1.A method for manufacturing a fuel cell assembly, comprising:
providing at least one fuel cell unit, wherein providing said at least one fuel cell unit comprises
providing at least one substrate; and
disposing at least one fuel cell component layer on said at least one substrate, said at least one component layer comprising at least one of an interconnect, an anode, a cathode, and an electrolyte;
wherein disposing comprises depositing said at least one component layer using an expanding-thermal-plasma coating apparatus.
- [c2] 2.The method of claim 1, wherein disposing comprises disposing a plurality of said fuel cell component layers.
- [c3] 3.The method of claim 2, wherein at least one layer comprising said plurality of layers has a thickness in the range from about 1 micron to about 50 microns.
- [c4] 4.The method of claim 3, wherein said thickness is in the range from about 2 microns to about 10 microns.
- [c5] 5.The method of claim 3, wherein each layer comprising said plurality of layers has a thickness in the range from about 1 micron to about 50 microns.
- [c6] 6.The method of claim 5, wherein said thickness of each layer is in the range from about 2 microns to about 10 microns.
- [c7] 7.The method of claim 2, wherein said apparatus comprises a plurality of deposition stations, and wherein depositing further comprises
positioning said at least one substrate onto at least one deposition station;
depositing at least one component layer onto said at least one substrate; and
transferring said at least one substrate to at least one different deposition station.
- [c8] 8.The method of claim 1, wherein disposing said at least one component layer comprises disposing an anode.

- [c9] 9.The method of claim 8, wherein disposing said anode comprises disposing a mixture comprising
at least one of a metal and a metal oxide; and
an electrolyte material.
- [c10] 10.The method of claim 9, wherein disposing said mixture comprises disposing a mixture comprising from about 20 volume percent to about 80 volume percent of said electrolyte material.
- [c11] 11.The method of claim 10, wherein said mixture comprises about 50 volume percent of said electrolyte material.
- [c12] 12.The method of claim 9, wherein said metal comprises at least one of nickel, copper, and silver.
- [c13] 13.The method of claim 9, wherein said metal oxide comprises one of nickel oxide, copper oxide, and silver oxide.
- [c14] 14.The method of claim 9, wherein said electrolyte material comprises an ionically conductive ceramic.
- [c15] 15.The method of claim 14, wherein said ceramic comprises at least one of stabilized zirconium oxide and cerium oxide.
- [c16] 16.The method of claim 1, wherein disposing said at least one layer comprises disposing at least one layer comprising at least one gradient in at least one parameter selected from the group consisting of composition and porosity.
- [c17] 17.The method of claim 16, wherein said at least one gradient of said at least one layer exists in a direction substantially parallel to said substrate.
- [c18] 18.The method of claim 16, wherein said at least one gradient of said at least one layer exists in a direction substantially perpendicular to said substrate.
- [c19] 19.The method of claim 1, wherein disposing said at least one component layer comprises disposing a cathode.
- [c20] 20.The method of claim 19, wherein disposing said cathode comprises

disposing a mixture comprising
at least one perovskite-structured ceramic material; and
an electrolyte material.

- [c21] 21.The method of claim 20, wherein disposing said mixture comprises disposing a mixture comprising from about 20 volume percent to about 80 volume percent of said electrolyte material.
- [c22] 22.The method of claim 20, wherein said mixture comprises about 50 volume percent of said electrolyte material.
- [c23] 23.The method of claim 20, wherein said perovskite-structured ceramic material comprises at least one of lanthanum strontium manganite, lanthanum calcium manganite, lanthanum strontium ferrite, lanthanum strontium cobalt ferrite, lanthanum strontium manganese ferrite, praseodymium strontium manganite, and praseodymium strontium manganese ferrite.
- [c24] 24.The method of claim 20, wherein said electrolyte material comprises an ionically conductive ceramic.
- [c25] 25.The method of claim 24, wherein said ceramic comprises at least one of stabilized zirconium oxide and cerium oxide.
- [c26] 26.The method of claim 1, wherein disposing said at least one component layer comprises disposing an electrolyte.
- [c27] 27.The method of claim 26, wherein said electrolyte comprises an ionically conductive ceramic.
- [c28] 28.The method of claim 27, wherein said ceramic comprises at least one of stabilized zirconium oxide and cerium oxide.
- [c29] 29.The method of claim 28, wherein disposing said electrolyte component layer comprises disposing a plurality of sub-layers, wherein each sub-layer comprises a material selected from said group consisting of stabilized zirconium oxide and cerium oxide.
- [c30] 30.The method of claim 1, wherein providing said at least one substrate

comprises providing at least one planar substrate.

- [c31] 31.The method of claim 1, wherein providing said at least one substrate comprises providing at least one non-planar substrate.
- [c32] 32.The method of claim 31, wherein providing said at least one non-planar substrate comprises providing at least one substrate having a cylindrical shape.
- [c33] 33.The method of claim 1, wherein providing said at least one substrate comprises providing at least one substrate comprising at least one of an anode, a cathode, and an electrolyte.
- [c34] 34.The method of claim 1, wherein providing said at least one substrate comprises providing at least one substrate comprising sacrificial material selected from the group consisting of polymers, salts, and carbon.
35.The method of claim 34, further comprising removing said sacrificial material.
- [c35] 36.The method of claim 1, wherein disposing said at least one component layer comprises disposing an interconnect.
- [c36] 37.The method of claim 36, wherein disposing said interconnect comprises disposing at least one conductive material selected from the group consisting of lanthanum chromite, stainless steel, alloys comprising cobalt and chromium, alloys comprising cobalt and nickel, and alloys comprising nickel and iron.
- [c37] 38.A method for manufacturing a fuel cell assembly, comprising:
providing at least one fuel cell unit, wherein providing said at least one fuel cell unit comprises
providing at least one substrate; and
disposing a plurality of fuel cell component layers on said at least one substrate, said plurality of component layers comprising
an anode comprising from about 20 volume percent to about 80 volume of at least one of stabilized zirconium oxide and cerium oxide and the balance comprising at least one of nickel and nickel oxide,
a cathode comprising from about 20 volume percent to about 80 volume

percent of at least one of stabilized zirconium oxide and cerium oxide and the balance comprising lanthanum strontium manganite, and an electrolyte comprising at least one of stabilized zirconium oxide and cerium oxide;

wherein disposing comprises depositing said at least one component layer using an expanding-thermal-plasma coating apparatus.

[c38] 39.The method of claim 38, wherein each layer comprising said plurality of layers has a thickness in the range from about 1 micron to about 50 microns.

[c39] 40.The method of claim 38, wherein said apparatus comprises a plurality of deposition stations, and wherein depositing further comprises positioning said at least one substrate onto at least one deposition station; depositing at least one component layer onto said at least one substrate; and transferring said at least one substrate to at least one different deposition station.

[c40] 41.A fuel cell assembly manufactured by a method, the method comprising providing at least one fuel cell unit, wherein providing said at least one fuel cell unit comprises providing at least one substrate; and disposing at least one fuel cell component layer on said at least one substrate, said at least one component layer comprising at least one of an interconnect, an anode, a cathode, and an electrolyte; wherein disposing comprises depositing said at least one component layer using an expanding-thermal-plasma coating apparatus.

[c41] 42.The fuel cell assembly of claim 41, wherein said anode comprises from about 20 volume percent to about 80 volume percent of at least one of stabilized zirconium oxide and cerium oxide and the balance comprises at least one of nickel and nickel oxide.

[c42] 43.The fuel cell assembly of claim 41, wherein said cathode comprises from about 20 volume percent to about 80 volume percent of at least one of stabilized zirconium oxide and cerium oxide and the balance comprises

lanthanum strontium manganite.

- [c43] 44.The fuel cell assembly of claim 41, wherein said electrolyte comprises at least one of stabilized zirconium oxide and cerium oxide.
- [c44] 45.The fuel cell assembly of claim 41, wherein said at least one substrate is cylindrical in shape.
- [c45] 46.The fuel cell assembly of claim 41, wherein said at least one layer comprises at least one gradient in at least one parameter selected from the group consisting of composition and porosity.
- [c46] 47.The fuel cell assembly of claim 46, wherein said at least one gradient of said at least one layer exists in a direction substantially parallel to said substrate.
- [c47] 48.The fuel cell assembly of claim 47, wherein said at least one parameter is porosity.
- [c48] 49.The fuel cell assembly of claim 41, wherein said at least one layer has a thickness in the range from about 1 micron to about 50 microns.
- [c49] 50.A fuel cell assembly manufactured by a method, the method comprising providing at least one fuel cell unit, wherein providing said at least one fuel cell unit comprises
providing at least one substrate; and
disposing a plurality of fuel cell component layers on said at least one substrate, wherein each layer comprising said plurality of layers has a thickness in the range from about 1 micron to about 50 microns, and wherein said plurality of component layers comprises
an anode comprising from about 20 volume percent to about 80 volume percent of at least one of stabilized zirconium oxide and cerium oxide and the balance comprising at least one of nickel and nickel oxide,
a cathode comprising from about 20 volume percent to about 80 volume percent of at least one of stabilized zirconium oxide and cerium oxide and the balance comprising lanthanum strontium manganite, and
an electrolyte comprising at least one of stabilized zirconium oxide and cerium

oxide;

wherein disposing comprises depositing said at least one component layer using an expanding-thermal-plasma coating apparatus.

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